Forces and Motion

PS-5 The student will demonstrate an understanding of the nature of forces and motion.

PS-5.9 Explain the relationship between mass and weight by using the formula $F_W = ma_g$.
Taxonomy Level: 2.7-B Understand Conceptual Knowledge

Key Concepts:
Force-weight (F_w)

Previous/Future knowledge: In the sixth grade students used a spring scale to measure forces including weight (6-1.1). In the 8th grade students analyzed the effects of forces (including gravity and friction) on the speed and direction of an object (8-5.3). In the 8th grade students explained the difference between mass and weight by using the concept of gravitational force (8-4.8).
In Physical Science students will explain the mathematical relationships among weight, mass, and acceleration due to gravity.

It is essential for students to understand
- The weight of an object is the force that gravity exerts on that object.
  - The weight of an object depends on its mass.
  - Given the mass of an object, its weight can be calculated using Newton's Second Law.
  - When an object is dropped, it accelerates at $9.8 m/s^2$. Because there is acceleration, there must be a force.
  - The force is equal to the mass times the acceleration. ($F_w = ma_g$)
  - The force called weight is equal to an object's mass times the acceleration due to gravity. ($9.8 m/s^2$)

It is essential for students to
- Solve problems involving the relationship among the weight and mass of objects and the acceleration of gravity using the formula $F_w = ma_g$. (This formula is sometimes written, $w = mg$.)

It is not essential for students to
- Solve problems in Standard English units or convert Standard English units to metric units.
- Solve problems involving scientific notation.
- Solve multi-step problems for this indicator that involve:
  - Determining the acceleration of an object from the initial velocity, final velocity and the time;
  - Determining the mass of an object from its weight in order to use the mass in another context.
- Solve problems that require considering opposing forces, such as wind resistance, or considering the forces on objects moving upward.

Assessment Guidelines:
The objective of this indicator is to *explain* the relationship between mass and weight, therefore, the primary focus of assessment should be to construct a cause and effect model of the relationship between mass and weight, using the formula ($F_w = ma_g$) as a basis for that relationship.
A second focus of assessment should be to apply the formula $F_w = ma_g$ to novel word problems or a new set of data, not just problems that are familiar.

In addition to *explain*, assessments may require that students:
- *Apply* procedures for manipulating the formula $F_w = ma_g$
- *Summarize* the relationship between the mass and the weight of an object;
- *Compare* the quantities of mass and weight in terms of the value each is measuring, the units for each, and the relationship between the two.